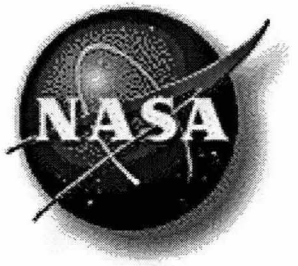

The Development of Project Orion Ground Safety Requirements

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NASA/Kennedy Space Center

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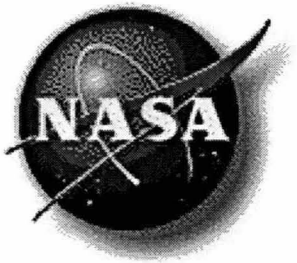
NASA Retired

Introduction



- Premise
  - A rigorous set of ground safety requirements is required to assure ground support equipment (GSE) and associated flight hardware ground operations are conducted safety
- This presentation will discuss as related to Project Orion:
  - Genesis of ground safety requirements
  - Establishment and approval process
  - Implementation
  - Current Status
  - Lessons Learned

Overview of Abort Flight Test (AFT) Project

- AFT designed to verify capabilities of a Launch Abort System (LAS)
  - The LAS purpose is to provide escape mechanism in either a pad abort or ascent abort
- Results used to build confidence in LAS and Command Module designs and analytical models
- Form the basis for GSE design and operations
  - Test as you fly and fly as you test

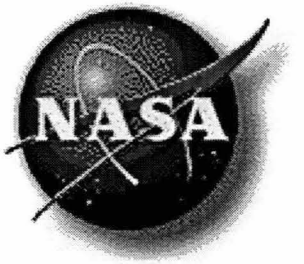
Establishment of Need

- During Project Technical Review – 2, an action was issued to development a set of ground safety requirements for AFT
- Driven by plan to conduct testing at NASA's Dryden Flight Research Center (DFRC) and the U.S. Army's White Sands Missile Range (WSMR)
- Additionally, WSMR required a rigorous set of Project safety requirements
  - Potential imposition of Air Force Space Command Manual 91-710
- Concern by design teams about impact

Forming the Team

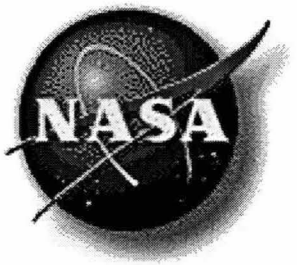
- Partnership between various Centers and the Prime Contractor
  - Johnson Space Center (JSC)
  - DFRC
  - Lockheed Martin (LM)
- The lead Centers, Johnson Space Center (JSC) and DFRC, lacked spacecraft ground processing safety expertise
  - Kennedy Space Center asked to support

Source Documents



- Early decision to use existing documents:
  - Kennedy Handbook (KHB) 1700.7 – "Space Shuttle Payload Ground Safety Handbook"
    - Established in the early 80's
    - Originally a joint book with both Eastern and Western Ranges
    - Lacked requirements for COPVs and Li-Ion Batteries
  - Kennedy NASA Procedures and Requirements (KNPR) 8715.3 – "KSC Safety Practices Procedural Requirements"
    - Contains processing lessons learned from last 50 years at KSC
  - AFSPCMAN 91-710 – "Range Safety Requirements"
    - Used to enhance any gaps in above documents
- Greatly assisted in development

Pulling It All Together

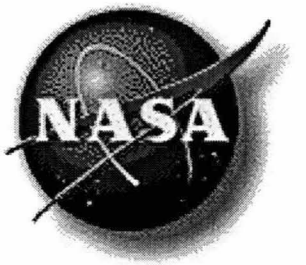


- Serious work began in March 2007
- In addition to the Safety core members, other safety members included:
  - WSMR
  - NASA White Sands Test Facility
  - Orbital Sciences (LM Sub-contractor)
  - Subject matter experts (e.g. Batteries)
- Key non-safety member was the Project Office
  - Challenged requirements

Issuing the Document

- Draft document (now titled CxP 72213, "Project Orion Ground Safety Design and Operational Requirements) released in Summer of 2007
- Numerous comments
  - Deficiencies obvious in hindsight
  - Value of outside reviewers
- Considerable discussion on scope of document
  - Approved as applicable to AFT only
  - Now (Revision B) across Project Orion
- Acceptance by WSMR as equivalent safety requirements followed Project approval

Implementation



- Mildly difficult
  - Change in culture
    - Experimen tal versus processing
  - Compressed schedules
  - Unforeseen circumstances
- "Time heals all wounds"
  - As the teams became familiar and used to the requirements, processing became smoother
- Living document

Lessons Learned

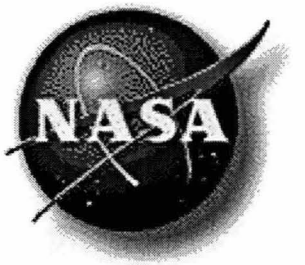
Think Ahead

- Any Team developing requirements must think ahead
  - What is the goal?
  - High enough to be applicable across the Program/Project
  - Don't get bogged down

"New" Project

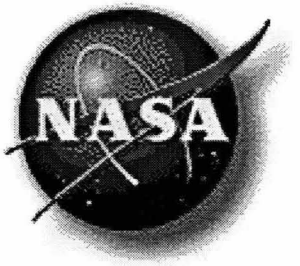
- Project Orion is a "new" Project
  - Little need for never before established requirements (although is possible)
  - Draw from existing requirements
    - " We're different/better"
    - Thor oughly review
  - Accept history (with a grain of salt)

Imposing Safety Requirements



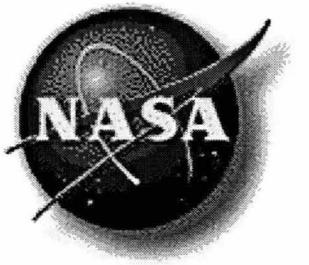
- Love/hate relationship
  - Hardware not designed to be inherently unsafe or to fail
  - Natural resistance to new requirements later in cycle
- Good safety requirements can actually help design and operations teams
  - Might even thank you (or maybe not)

One Stop Shopping



- One book for safety requirements
  - Design organizations prefer safety drivers in their design documents
  - Safety prefers to own these requirements
    - Independen t review authorities
  - Potential multiple locations of requirements
  - Solution is not clear
    - T echnical Authorities
- Operations versus design

Flexibility

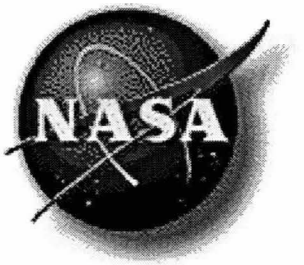


- When in the early stages of a test program, flexibility in interpreting and enforcing the requirements is key
  - Spirit vs. Letter
  - Understand the basis of the requirement
- However, a firm line must be established
- Difficult tightrope
  - Stress

Scope

- Scope is critical
- Once decided, ensure all affected parties recognize document
  - Undertand their role
- Potential problems if not recognized
  - Non compliant hardware
  - Flight and ground

Obstacles on the Path to Success

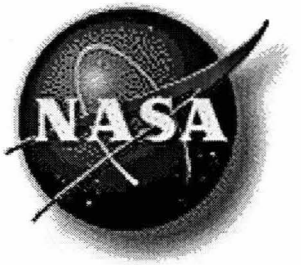


- Be aware of the obstacles
- In conjunction with understanding the basis of the requirements, can assist in determining flexibility

Multiple Jurisdictions

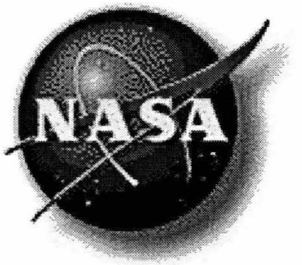
- Because CxP 72213 is applicable in multiple jurisdictions, the issue of how local requirements would be included needed to be addressed.
- Site Safety Plan
  - A place where local requirements and processes are documented
  - Mandatory training
- Keeps document from being swamped with "here but not here" type requirements
- Safety Approval Authority
  - Recognizes local authorities
  - Allows their buy into certain changes

Many Thanks



- Bill Condzella/Dryden
- Jeff Williams/JSC
- John Trainor/Project Orion CSO
- Don Reed/AFT Project Manager

Summary



In spite of a very compressed schedule, Project Orion's AFT safety team was able to pull together a comprehensive set of ground safety requirements using existing requirements and subject matter experts. These requirements will serve as the basis for the design of GSE and ground operations. Using the above lessons as a roadmap, new Projects can produce the same results.